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**FORAGE SEED PRODUCTION AND QUALITY CONTROL
FOCUSING ON WEED CONTROL AND HARVEST
MANAGEMENT**

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Forage Seed Production and Quality Control, Focusing on Weed Control

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Executive Summary

Based on input from provincial Forage Specialists, data was generated to pursue minor use registration of Puma Super in a number of forage grass species grown for seed production. Fourteen studies were conducted at Scott on seedling and established stands of 5 different grass species from 2003-05. In 2004-05, studies were conducted at Melfort on four different species. Results are summarized below:

Seedling Crested wheatgrass – At both Scott and Melfort, crested wheatgrass exhibited good tolerance to Puma Super with no adverse effect on seed yield.

Established Crested wheat grass – Puma Super applied at the 1X and 2X rate to established Crested wheat grass in 2004 resulted in acceptable (< 10%) injury. Despite the lack of observed injury, Puma Super applied at the 2X rate caused a significant reduction in yield compared to Puma Super at the 1X rate.

Seedling intermediate wheat grass – Puma Super applied at the 1X and 2X to seedling intermediate wheatgrass did not result in significant plant injury and did not reduce seed yields relative to the industry standard or untreated check.

Established intermediate wheat grass – Visual observations from one study initiated in 2004 indicated that Puma Super applied at the 1X and 2X rate resulted in acceptable (< 10%) injury. No significant seed yield reduction was associated with Puma Super even at the 2X rate. Germination tests showed no evidence that Puma Super reduced germination rates of the seed relative to the untreated check or the industry standard (Achieve 80 DG).

Meadow brome grass - No significant crop injury or yield reduction resulted from Puma Super application in two studies conducted at Scott and one study conducted at Melfort.

Smooth Brome grass seedlings – Smooth brome grass was tolerant to seedling applied Puma Super under the growing conditions that existed at Scott in 2004 and 2005 (two experiments).

Tall fescue – Visual observations indicated acceptable levels of injury (stunting) for Puma Super. Yields were not reduced from Puma Super application in any of the three studies conducted.

Herbicide treatments mentioned in this report are not registered for use and their use is not recommended by the researchers involved. Use of these products is entirely at the risk of the producer or company involved.

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1.0 ABSTRACT

Data was generated to pursue minor use registration of Puma Super in a number of forage grass species grown for seed production. Fourteen studies were conducted at Scott on seedling and established stands of 5 different grass species from 2003-05. Studies were also conducted at Melfort on four different grass species in 2004-05. Seedling crested wheatgrass exhibited good tolerance to Puma Super with no adverse effect on seed yield. Puma Super applied in established crested wheat grass at the 1X and 2X rate resulted in acceptable (< 10%) injury. Despite the lack of observed injury, Puma Super applied at the 2X rate caused a significant reduction in yield compared to Puma Super at the 1X rate. Seedling and established intermediate wheatgrass, meadow brome grass, smooth brome grass and tall fescue exhibited acceptable tolerance with no reduction in seed yields when Puma Super was applied at both 1X and 2X rates.

2.0 OBJECTIVE

To evaluate the tolerance of a number of forage grass species grown for seed production to the graminicide Puma Super (fenoxyprop-p-ethyl). Puma Super is a herbicide which effectively controls grass weeds such as wild oat and green foxtail, which are problematic for forage seed producers.

3.0 INTRODUCTION

Evaluation of tolerance of forage grasses for seed production requires an initial year of establishment followed by yield measurements in the second year. Registration of pesticides is based on timing with applications occurring at either the seedling or established stage of growth.

This project was initially intended to conduct research on the tolerance of forage grass species to Avadex Mico-Active (triallate). However, the manufacturer (Monsanto) withdrew the herbicide from the market in 2003. Therefore, the project objectives were changed in 2003 to those listed above. In addition, the Saskatchewan Forage Council suspended their field research program in 2003 and transferred the project to scientists at Scott in the spring of 2004.

Since the efficacy of Puma Super on the control of grassy weed species is well documented in a number of other cereal crops, there was no need to repeat weed control efficacy trials. In addition, the end use is seed production, and since there is no consumption of the seed or fodder by humans or livestock, there is no need to conduct pesticide residue trials. To satisfy PMRA registration requirements, the forage grasses must be shown to be tolerant to Puma Super. Tolerance is determined by visual injury ratings and by seed yield. In order for registration to occur on both seedling (year of establishment) and established forage species, tolerance trials must be conducted in separate seedling and established forage stands.

Consultations with provincial forage specialists identified a number of species for which additional seedling and established tolerance trials to Puma Super were required. The number of species evaluated was based on available resources.

Fourteen trials conducted at the Scott Research Farm and four trials conducted at Melfort are reported. Tolerance trials were conducted on the following species: tall fescue; intermediate wheat grass, crested wheat grass, meadow brome grass and smooth brome grass. Guardian was seeded at 5 kg/ha, Chief and Paddock were seeded at 7 kg/ha, Parkland at 4.5 kg/ha, and Magna at 8 kg/ha. Only certified seed was used.

In order to demonstrate crop tolerance, the herbicide must be applied to the crop at both the 1X label rate and two

times the label rate.

The following materials and methods were consistent across all trials conducted at Scott and Melfort.

Soil Description at Scott:

Texture: Loam **% OM:** 4 **% Sand:** 31 **% Silt:** 42 **% Clay:** 27
pH: 6 **Soil Association:** Scott **Fertility Level:** Good

Soil Description at Melfort:

Texture: Silty Clay Loam **% OM:** 10.6 **pH:** 5.6
Soil Association: Melfort **Fertility Level:** Excellent

At Scott, all plots were seeded at a row spacing of 45.7 cm using a hoe-drill equipped with on-row packing. All experiments employed Randomized Complete Block experimental design with 4 replicates. Plot size was 2 X 5 meters.

At Scott, herbicide applications were made with a Rogers shrouded sprayer equipped with 80015 flat fan nozzles and calibrated to apply a carrier volume of 100 l/ha at an operating pressure of 275 kpa. Carbon dioxide was used as the propellant.

At Melfort, seeding was done with a double disc press drill at a seeding depth of 1 cm and 30 cm row spacing. The plot size was 5 feet wide by 20 feet long. The test area had been seeded to wheat for ground cover and sprayed out with glyphosate prior to heading in 2003. In 2002 it was seeded to barley, sprayed with Puma and Buctril M and harvested for seed. In 2001 it was summerfallowed. Fertility levels were adequate to establish a grass seed crop. Spraying was done with an air assist self-propelled plot sprayer that applied 110 l/ha of product using an operating pressure of 275 kpa.

For data collection, the rating scale that was used was % visual injury. Ratings and their significance are based on guidelines found in the paper 'Guidelines for the conduct of chemical weed control trials in forage grass grown for seed' (Darwent, A.L. et al.). The document describes phytotoxicity from 0-9% as 'acceptable', 10-20% where slight discoloration and/or stunting occurs as 'just acceptable', 21-30% as 'not acceptable', and >30% as severe which accounts for the ability of grasses to recover from injury (Darwent, A.L. et al.).

For statistical analysis to increase the degrees of freedom and improve the precision of the analyses other pesticides under investigation were retained in the analyses. However only results from the applications of Puma Super, the untreated check, and Puma 92 Super (old formulation) are discussed here.

Environmental data from both locations are reported in the APPENDIX. Equivalent rates of herbicides expressed in liters/acre are presented in Table 17 in the APPENDIX.

4.0 TOLERANCE OF CRESTED WHEATGRASS TO PUMA SUPER

4.1 SEEDLING CRESTED WHEATGRASS

4.1.a Introduction

Crested wheatgrass is a widely adapted grass species that been used for both hay production and pasture production purposes. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in crested wheatgrass. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of crested wheatgrass. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

4.1.b Materials and Methods

Scott Seedling Trial

This trial was fall dormant seeded directly into wheat stubble on October 28, 2003 and emerged on April 28, 2004. The cultivar Parkland was seeded at a rate of 4.5 kg/ha with a hoe-drill using a 45.7 cm row space. Plots were harvested with a Wintersteiger plot combine on August 5, 2005. Seed was dried, cleaned and weighed.

In the week preceding application 29.8 mm of rain fell with 2.2 mm falling within 10 days after application. The first significant rainfall after application occurred on July 1 when 11.8 mm of precipitation was recorded. The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather.

The year 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees Celsius below normal respectively. Precipitation over the course of the growing season May- August averaged 53% more than the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in minimal damage in the form of broken stems. Damage was consistent across the trial with no other impact than a slight reduction in seed yield.

Maintenance weed control consisted of a combination of hand weeding and mowing in 2004. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows. In 2005 broadleaf weed seedlings were controlled with a early spring application of 2, 4-D Amine followed by hand weeding.

Melfort Seedling Trial

A test area at the Melfort Research Farm was seeded to Kirk crested wheatgrass June 24, 2004 @ 9 kg/ha.

Treatment application was done on August 1, 2004 in a randomized complete block design with the crested wheatgrass plants at anywhere from the 2 to 6 leaf stage. Environmental conditions at and near the time of application are presented in Table 16 (APPENDIX). Visual ratings on % injury were done at 14 days after treatment (DATt). Injury ratings at 28 DAT and 42 DAT were not done due to an encroachment and unplanned grazing of the test area by cattle. However, it is unlikely that the grazing had any effect on the final seed yield. The test area was fertilized April 26, 2005, with 89 kg/ha N in the form of ammonium nitrate.

Fall precipitation in 2004 was about 115% of the long term average and provided ideal moisture conditions for going into winter. Precipitation from January 1 to August 30, 2005 was nearly 170% of normal. Grass establishment was good with considerable amounts of biomass production.

The test was swathed with a self propelled plot swather August 22, 2005. The swaths were allowed to dry enough in the field to be combined. Combining was done with a Wintersteiger plot combine on August 30, 2005. The seed harvested from each plot was then dried in a forced air drier and subsequently cleaned with a Clipper table top seed cleaner to determine clean seed yields.

4.1.c Results and Discussion

Scott Seedling Trial

Results are summarized in Table 1. In 2004 visual observations indicated no evidence of crested wheat grass injury to Puma Super with the exception of 41 days after application when evidence of slight stunting (<5%) was observed. Crop injury in 2005, in the form of stunting remained below 5% with no significant reduction in seed yield ($P=0.05$) relative to the untreated check or industry standard. Seed yield across the trial averaged 734 kg/ha.

Melfort Trial:

Results are presented in Table 2. There were no significant differences in the reduction of seed yield from treatment application. Significant differences were seen in the visual injury assessments done at 14DAT. However, tolerance to the herbicides tested was within the acceptable range (< 20%).

Table 1: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling crested wheatgrass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Crested Wheatgrass Visual Injury Percent 25-Jun-04	Crested Wheatgrass Visual Injury Percent 9-Jul-04	Crested Wheatgrass Visual Injury Percent 27-Jul-04	Crested Wheatgrass Visual Injury Percent 14-Jun-05	Crested Wheatgrass Visual Injury Percent 11-Jul-05	Crested Wheatgrass Seed Yield kg/ha 5-Aug-05
1	WEED FREE CHECK		0 a	0 a	0 a	0 a	3 ab	1046 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	4 a	0 a	3 ab	1039 a
3	PUMA SUPER	184 g ai/ha	0 a	0 a	2 a	0 a	2 ab	915 a
4	PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0 a	0 a	1 a	0 a	0 b	982 a
5	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0 a	0 a	0 a	0 a	1 ab	937 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	0 a	0 a	7 a	0 a	3 ab	812 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	0 a	0 a	2 a	0 a	5 a	788 a
8	BANVEL II	140 g ai/ha	0 a	0 a	0 a	0 a	3 ab	974 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 a	0 a	0 b	1078 a
10	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	0 a	0 a	0 a	0 a	3 ab	1052 a
11	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	0 a	0 a	0 a	0 a	0 b	983 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	1 ab	966 a
Tukey's HSD (P=.05)			0	0	4.9	0	4.7	280.3
Standard Deviation			0	0	3.4	0	1.9	194.1
CV			0	0	253.95	0	106.17	20.13
Treatment Prob(F)			1	1	0.1367	1	0.0258	0.5666

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 2. Visual injury and seed yield from application of Puma Super and other herbicides to a seedling crested wheatgrass stand – Melfort 2004-05.

Treatment	Rate	Crested Wheatgrass Injury Percent 14 DAT	Crested Wheatgrass Seed yield kg/ha
UNTREATED CHECK		0b	944ab
PUMA SUPER	92 gai/ha	0b	947ab
PUMA SUPER	184 g ai/ha	0b	869bc
PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0b	962ab
PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0b	887bc
ATTAIN FLUROXYPYR 2,4-D LV ESTER	105 g ai/ha 560 g ai/ha	0b	890bc
ATTAIN FLUROXYPYR 2,4-D LV ESTER	210 g ai/ha 1120 g ai/ha	0b	793c
BANVEL II	140 g ai/ha	0b	1019a
ACHIEVE 80 DG TURBOCHARGE	198 g ai/ha 0.5% v/v	0b	925ab
SPECTRUM FLORASULAM CURTAIL-M	5 g ai/ha 490 g ai/ha	0b	863bc
SPECTRUM FLORASULAM CURTAIL-M	10 g ai/ha 980 g ai/ha	0b	887bc
PUMA 92 SUPER	92 g ai/ha	6.25a	967ab
MEAN		0.52	912.4
CV		138.5	9.8
LSD alpha= .05		1.04	128.9
Pr>F		<.0001	ns .0961

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

4.2 ESTABLISHED CRESTED WHEATGRASS

4.2.a Materials and Methods

There was one trial conducted on established crested wheatgrass at Scott, SK.

Parkland crested wheatgrass was seeded at a rate 4.5 kg/ha on June 10, 2003. Plots were harvested on August 4, 2004.

Maintenance weed control consisted of a combination of maintenance herbicides, hand weeding and mowing. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between rows.

Herbicide treatments were applied on May 17, 2004. In the week preceding application 4.8 mm of rain fell with 2.0 mm falling within 10 days after application. The first significant rainfall after application occurred on May 29 when 15.2 mm of precipitation was recorded. In 2003 precipitation was below normal in May (20.3 mm vs long term average of 36 mm) and in June (31.3 mm vs long term average of 60.0 mm) but near normal for the remainder of the growing season. Temperatures in July and August of 2003 were above normal averaging 1.2 and 1.9 degrees above normal respectively. The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively

4.2.b Results and Discussion

Crop establishment was uniform and very competitive with weeds kept in check by crop competition in 2004. Results are presented in Table 3.

Tolerance of established Crested Wheat grass to Puma Super applied at the 1X and 2X rate was classed as acceptable (< 10% injury) with very low levels of injury observed. Despite the lack of observed injury Puma Super applied at the 2X rate caused a significant reduction in yield of 351 kg/ha compared to Puma Super 1X (1327 kg/ha), 479 kg/ha less then the weed free check (1455 kg/ha) and 601 kg/ha less than the industry standard Achieve 80 DG (1577 kg/ha). This data indicates Crested Wheat grass was not tolerant to Puma Super applied to established Crested wheat grass at the 2X rate under the growing conditions experienced at Scott, Saskatchewan in 2004.

Percent germination tests conducted on 100 seeds/plot between March and April of 2005 showed no evidence that Puma Super reduced germination rates of the seed relative to the untreated check or industry standard Achieve 80 DG.

4.3 CONCLUSIONS

These two studies indicate seedling crested wheat grass grown for seed production tolerated Puma Super under the environmental conditions experienced at Scott and Melfort, SK in 2004 and 2005. Puma 92 Super which was

included to create a bridged data set with Puma Super also showed little evidence of visual injury and no reductions in seed yield.

Although this is only one study, there was indication that established crested wheatgrass did not tolerate Puma Super since its yield declined significantly when Puma Super was applied at the 2X rate.

Table 3: Visual injury and seed yield from application of Puma Super and other herbicides to an established crested wheatgrass stand – Scott 2003-04.

Trt. No.	TREATMENT	Rate	Crested Wheatgrass Visual Injury Percent 27-May-04	Crested Wheatgrass Visual Injury Percent 14-Jun-04	Crested Wheatgrass Visual Injury Percent 25-Jun-04	Crested Wheatgrass Visual Injury Percent 22-Jul-04	Crested Wheatgrass Yield kg/ha 4-Aug-04	Crested Wheatgrass Seed Germination Percent 5-Aug-05
1	WEED FREE CHECK		0 a	0 a	0 b	0 b	1454.7 ab	47 ab
2	PUMA SUPER	92 g ai/ha	1 a	0 a	0 b	0 b	1327.4 abc	44 ab
3	PUMA SUPER	184 g ai/ha	3 a	0 a	0 b	0 b	976 c	49 ab
4	PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0 a	0 a	0 b	0 b	1237.2 abc	37 ab
5	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0 a	0 a	0 b	0 b	896 cd	26 bc
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	1 a	0 a	0 b	1 ab	1425.5 ab	52 ab
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	0 a	0 a	0 b	0 b	1224.4 abc	49 ab
8	BANVEL II	140 g ai/ha	1 a	0 a	5 a	4 a	458 d	3 c
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 b	0 b	1577.4 a	48 ab
10	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	1 a	0 a	0 b	0 b	1341.9 abc	48 ab
11	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	3 a	0 a	0 b	0 b	1007.5 bc	35 ab
12	PUMA 92 SUPER	92 g ai/ha	1 a	0 a	0 b	0 b	1548.2 a	56 a
Tukey's HSD (P=.05)			3.3	0	2.9	3.6	449.1	28.6
Standard Deviation			2.3	0	1.2	1.5	180.73	11.5
CV			246	0	282.84	391.38	14.98	27.98
Treatment Prob(F)			0.7578	1	0.0001	0.041	0.0001	0.0001

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

5.0 TOLERANCE OF INTERMEDIATE WHEAT GRASS TO PUMA SUPER

5.1. SEEDLING INTERMEDIATE WHEAT GRASS

5.1.a Introduction

Intermediate wheatgrass is a widely adapted grass species that has been used primarily for hay production with secondary uses as well. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in intermediate wheatgrass. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of intermediate wheatgrass. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

5.1.b Materials and Methods

Scott Seedling Trial

This trial was fall dormant seeded directly into wheat stubble on October 28, 2003 and emerged on April 28, 2004. Chief intermediate wheatgrass was seeded at a rate of 7 kg/ha. Plots on were harvested on August 10, 2005.

Maintenance weed control consisted of a combination of hand weeding and mowing in 2004. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows. In 2005 broadleaf weed seedlings were controlled with a combination of early spring application of 2, 4-D Amine followed by hand weeding.

Treatments were applied on June 16, 2004. In the week preceding application 29.8 mm of rain fell with 2.2 mm falling within 10 days after application. The first significant rainfall after application occurred on July 1 when 11.8 mm of precipitation was recorded. The year 2004 was characterized by near normal precipitation throughout the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather.

The year 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees Celsius below normal respectively. Precipitation over the course of the growing season May- August averaged 53% more than the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in broken stems. Damage however was consistent across the trial with no other impact than a general reduction in seed yield. Plots were harvested on August 10, 2005.

Melfort Seedling Trial

A test area at the Melfort Research Farm was seeded to Chief intermediate wheatgrass June 24, 2004 @ 9 kg/ha.

Fall precipitation in 2004 was about 115% of the long term average and provided ideal moisture conditions for going into winter. Precipitation from January 1 to August 30, 2005 was nearly 170% of normal. Grass establishment was good with considerable amounts of biomass production.

Treatment application was done on August 1, 2004 in a randomized complete block design with the intermediate wheatgrass plants at anywhere from the 3 to 5 leaf stage. Environmental conditions at and near the time of application are presented in Table 16 (APPENDIX). Visual ratings on % injury were done at 14 days after treatment (DAT). Injury ratings at 28 DAT and 42 DAT were not done due to an encroachment and unplanned grazing of the test area by cattle. However, it is unlikely that the grazing had any effect on the final seed yield. The test area was fertilized April 26, 2005, with 89 kg/ha N in the form of ammonium nitrate.

The test was swathed with a self propelled plot swather August 22, 2005. The swaths were allowed to dry enough in the field to be combined. Combining was done with a Wintersteiger plot combine on August 30, 2005. The seed harvested from each plot was then dried in a forced air drier and subsequently cleaned with a Clipper table top seed cleaner to determine clean seed yields.

5.1.c Results and Discussion

Scott Seedling Trial

Results are presented in Table 4. Visual observations in 2004 indicated no evidence of injury either at 9, 23 or 41 days after application with Puma Super regardless of rate or formulation at the 1Xrate. In 2005 injury associated with seedling applied Puma Super remained below 3% with no reductions in seed yield relative to the untreated check or industry standard. Seed yield across the trial averaged 363 kg/ha or approximately 50% less than seed yields obtained from trials harvested in 2004 due primarily to hail damage incurred on July 13th, 2005.

Melfort Seedling Trial

Data is summarized in Table 5. There were no significant reductions of seed yield from treatment application. Significant differences were seen in the visual injury assessments done at 14DAT. However, tolerance to the herbicides tested was within the acceptable range (< 20%).

Table 4: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling intermediate wheatgrass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Intermediate Wheatgrass Visual Injury Percent 25-Jun-04	Intermediate Wheatgrass Visual Injury Percent 9-Jul-04	Intermediate Wheatgrass Visual Injury Percent 27-Jul-04	Intermediate Wheatgrass Visual Injury Percent 14-Jun-05	Intermediate Wheatgrass Visual Injury Percent 11-Jul-05	Intermediate Wheatgrass Seed Yield kg/ha 10-Aug-05
1	WEED FREE CHECK		0 a	0 a	0 a	0 a	1 a	420 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	471 a
3	PUMA SUPER	184 g ai/ha	0 a	0 a	0 a	0 a	2 a	388 a
4	PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0 a	0 a	2 a	0 a	0 a	487 a
5	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0 a	0 a	1 a	0 a	0 a	485 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	0 a	0 a	0 a	0 a	0 a	496 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	210 g ai/ha 1120 g ai/ha	0 a	0 a	0 a	0 a	1 a	490 a
8	BANVEL II	140 g ai/ha	0 a	0 a	1 a	0 a	0 a	510 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 a	0 a	0 a	501 a
10	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	0 a	1 a	0 a	0 a	0 a	478 a
11	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	0 a	0 a	0 a	0 a	2 a	532 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	471 a
Tukey's HSD (P=.05)			0	1	2.1	0	2.3	94.4
Standard Deviation			0	0.7	1.4	0	1.6	65.4
CV			0	692.82	431.17	0	340.59	13.69
Treatment Prob(F)			1	0.4671	0.6001	1	0.5735	0.2131

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 5: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling intermediate wheatgrass stand – Melfort 2004-05.

Treatment	Rate	Intermediate Wheatgrass Injury Percent 14 DAT	Intermediate Wheatgrass Seed yield kg/ha
UNTREATED CHECK		0b	1206a
PUMA SUPER	92 gai/ha	^a 0b	1153ab
PUMA SUPER	184 g ai/ha	0b	1181a
PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0b	1064b
PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0b	1191a
ATTAIN FLUROXYPYR 2,4-D LV ESTER	105 g ai/ha 560 g ai/ha	0b	1142ab
ATTAIN FLUROXYPYR 2,4-D LV ESTER	210 g ai/ha 1120 g ai/ha	0b	1146ab
BANVEL II	140 g ai/ha	0b	1151ab
ACHIEVE 80 DG TURBOCHARGE	198 g ai/ha 0.5% v/v	0b	1122ab
SPECTRUM FLORASULAM CURTAIL-M	5 g ai/ha 490 g ai/ha	0b	1121ab
SPECTRUM FLORASULAM CURTAIL-M	10 g ai/ha 980 g ai/ha	0b	1057b
PUMA 92 SUPER	92 g ai/ha	8.75a	1183a
MEAN		0.73	1143
CV		99	7
LSD alpha= .05		1.04	115
Pr>F		<.0001	ns 0.2324

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

5.2 ESTABLISHED INTERMEDIATE WHEAT GRASS

5.2.a Materials and Methods

This trial was seeded on June 10, 2003 and harvested on August 12, 2004. Chief Intermediate wheat grass was seeded at a rate of 7 kg/ha.

Herbicide treatments were applied on May 17, 2004. In the week preceding application 4.8 mm of rain fell with 2.0 mm falling within 10 days after application. The first significant rainfall after application occurred on May 29 when 15.2 mm of precipitation was recorded. In 2003 precipitation was below normal in May (20.3 mm vs long term average of 36 mm) and in June (31.3 mm vs long term average of 60.0 mm) but near normal for the remainder of the growing season. Temperatures in July and August of 2003 were above normal averaging 1.2 and 1.9 degrees above normal respectively. The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1 , 1.4, and 1.9 degrees Celsius below normal respectively

5.2.b Results and Discussion

Crop establishment was uniform and very competitive with weeds kept in check by crop competition in 2004. Results are presented in Table 6. Tolerance of established Intermediate wheat grass to Puma Super applied at the 1X and 2X rate was rated as acceptable (< 10% injury) with only slight injury in the form of stunted growth at 10 days after application. No significant seed yield reduction was associated with Puma Super even at the 2X rate. Seed yields from plots treated with Puma Super at the 1X and 2X rates yielded 888 kg/ha and 806 kg/ha, respectively compared to 935 kg/ha for the weed free check and 881 kg/ha for the industry standard Achieve 80 DG.

5.2.c Conclusion

This data suggests Intermediate Wheat grass was tolerant to Puma Super applied even at the 2X rate under the growing conditions experienced at Scott, Saskatchewan in 2003 and 2004. Percent germination tests conducted on 100 seeds/plot between March and April of 2005 showed no evidence that Puma Super reduced germination rates of the seed relative to the untreated check or industry standard Achieve 80DG.

5.3 CONCLUSIONS

Results indicate that both seedling and established intermediate wheat grass tolerated both 1X and 2X rates of Puma Super under the environmental conditions experienced at Scott and Melfort from 2003 to 2005.

Table 6: Visual injury and seed yield from application of Puma Super and other herbicides to an established intermediate wheatgrass stand – Scott 2003-04.

Trt. No.	TREATMENT	Rate	Intermediate Wheatgrass Visual Injury Percent 27-May-04	Intermediate Wheatgrass Visual Injury Percent 14-Jun-04	Intermediate Wheatgrass Visual Injury Percent 25-Jun-04	Intermediate Wheatgrass Visual Injury Percent 22-Jul-04	Intermediate Wheatgrass Seed Yield kg/ha 4-Aug-04	Intermediate Wheatgrass Seed Germination Percent
1	WEED FREE CHECK		0 b	0 a	0 b	0 b	934.7 a	22 a
2	PUMA SUPER	92 g ai/ha	0 b	0 a	0 b	0 b	888.1 a	21 a
3	PUMA SUPER	184 g ai/ha	4 ab	0 a	0 b	0 b	806.1 a	22 a
4	PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0 b	0 a	0 b	0 b	942.3 a	21 a
5	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	4 ab	0 a	0 b	0 b	901.6 a	18 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	0 b	0 a	0 b	0 b	779.9 a	18 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	6 a	0 a	0 b	0 b	925.2 a	20 a
8	BANVEL II	140 g ai/ha	0 b	0 a	9 a	8 a	734.9 a	15 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 b	0 a	0 b	0 b	880.6 a	26 a
10	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	0 b	0 a	0 b	0 b	907.5 a	24 a
11	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	4 ab	0 a	0 b	0 b	992.1 a	29 a
12	PUMA 92 SUPER	92 g ai/ha	0 b	0 a	0 b	0 b	873.4 a	27 a
Tukey's HSD (P=.05)			5.5	0	5.4	4.5	181.46	9.4
Standard Deviation			2.2	0	2.2	1.8	125.68	6.5
CV			153.14	0	296.92	261.94	14.27	29.66
Treatment Prob(F)			0.0008	1	0.0001	0.0001	0.2344	0.1616

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

6.0 TOLERANCE OF SEEDLING MEADOW BROME GRASS TO PUMA SUPER

6.0.a Introduction

Meadow brome grass is a widely adapted grass species that has been used primarily for pasture production. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in meadow brome grass. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of meadow brome grass. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

6.0.b Materials and Methods

Scott Seedling Trial 1

This trial was fall dormant seeded directly into wheat stubble on October 28, 2003 and emerged on April 28, 2004. The cultivar was Paddock and seeding rate was 7 kg/ha.

Maintenance weed control consisted of a combination of hand weeding and mowing in 2004. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows. In 2005 broadleaf weed seedlings were controlled with a early spring application of 2, 4-D Amine followed by hand weeding.

Herbicide treatments were applied on June 16, 2004. In the week preceding application 29.8 mm of rain fell with 2.2 mm falling within 10 days after application. The first significant rainfall after application occurred on July 1 when 11.8 mm of precipitation was recorded

Scott Seedling Trial 2

This trial was seeded directly into wheat stubble on June 9, 2004. Paddock meadow brome grass was seeded at a rate of 7.5 kg/ha.

Maintenance weed control was the same as Scott Seedling Trial 1. Herbicide treatments were applied on July 13, 2004. In the week preceding application 14 mm of rain fell with 11.8 mm falling within 10 days after application. The first significant rainfall after application occurred on July 20 when 6.4 mm of precipitation was recorded.

At Scott, the year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather.

At Scott, 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees

Celsius below normal respectively. Precipitation over the course of the growing season May- August averaged 53% more than the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in minimal damage in the form of broken stems. Damage was consistent across the trial with no other impact than a slight reduction in seed yield. Plots were harvested on July 25, 2005.

Melfort Seedling Trial

A test area at the Melfort Research Farm was seeded to Fleet meadow brome grass June 24, 2004 @ 9 kg/ha.

Fall precipitation in 2004 was about 115% of the long term average and provided ideal moisture conditions for going into winter. Precipitation from January 1 to August 30, 2005 was nearly 170% of normal. Grass establishment was good with considerable amounts of biomass production.

Treatment application was done on August 1, 2004 in a randomized complete block design with the meadow brome grass plants at anywhere from the 3 to 6 leaf stage. Environmental conditions at and near the time of application are presented in Table 16 (APPENDIX).

Visual ratings on % injury were done at 14 days after treatment (DAT). Injury ratings at 28 DAT and 42 DAT were not done due to an encroachment and unplanned grazing of the test area by cattle. However, it is unlikely that the grazing had any effect on the final seed yield. The test area was fertilized April 26, 2005, with 89 kg/ha N in the form of ammonium nitrate.

The test was swathed with a self propelled plot swather August 4, 2005. The swaths were allowed to dry enough in the field to be combined. Combining was done with a Wintersteiger plot combine on August 22, 2005. The seed harvested from each plot was then dried in a forced air drier and subsequently cleaned with a Clipper table top seed cleaner to determine clean seed yields.

6.0.c Results and Discussion

Scott Seedling Trial 1

Results are presented in Table 7. In 2004, visual observations indicated little evidence of Meadow Brome grass injury to Puma Super with the exception of 41 days after application when evidence of slight stunting was observed at the 2X rate. In 2005 injury remained very low (<2%) and no significant differences in seed yield between treatments were observed ($P=0.05$). Seed yield across the trial averaged 536 kg/ha or approximately 30% less than yields obtained from meadow brome grass trials harvested in 2004. Reduction in yield was a function of hail damage but also a thinner plant stand. This reduction in crop establishment made the crop more susceptible to weed infestation. Although plots were thoroughly hand weeded on June 10th variable weed competition across the trial may have already impacted on seed yield and contributed to the high seed yield coefficient of variation (37%). Despite the variability and subsequent reduction in ability to detect yield differences there was no observed trend toward reduced seed yields where Puma Super was applied.

Scott Seedling Trial 2

Results are presented in Table 8. In 2004 visual observations indicated little evidence of meadow brome grass injury to Puma Super even at the 2 X rate. In 2005 there were no symptoms of injury to Puma Super and no significant differences in seed yield between treatments were observed ($P=0.05$). Seed yield across the trial averaged 617 kg/ha or approximately 15% less than yields obtained from meadow brome grass trials harvested in 2004. Reduction in yield was primarily a function of hail damage.

Melfort Seedling Trial

Results are presented in Table 9. There were no significant differences in the reduction of seed yield from treatment application. No injury was detected as seen in the visual injury assessments done at 14 DAT.

6.1 CONCLUSIONS

These results suggest that Meadow Brome grass seedlings were tolerant to applications of Puma Super under the conditions experienced at Scott and Melfort in 2004 and 2005. Puma 92 Super which was included to create bridged data with Puma Super showed similar levels of injury at the same rate with no observed reductions in yield.

Table 7: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling meadow brome grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Meadow Brome grass Visual Injury Percent 25-Jun-04	Meadow Brome grass Visual Injury Percent 9-Jul-04	Meadow Brome grass Visual Injury Percent 27-Jul-04	Meadow Brome grass Visual Injury Percent 14-Jun-05	Meadow Brome grass Visual Injury Percent 11-Jul-05	Meadow Brome grass Seed Yield kg/ha 25-Jul-05
1	WEED FREE CHECK		0 a	0 a	0 a	0 a	0 a	599 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	866 a
3	PUMA SUPER	184 g ai/ha	0 a	0 a	1 a	0 a	1 a	745 a
4	PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0 a	0 a	0 a	0 a	0 a	743 a
5	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0 a	0 a	0 a	0 a	0 a	461 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	0 a	0 a	1 a	0 a	0 a	797 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	0 a	1 a	3 a	0 a	1 a	685 a
8	BANVEL II	140 g ai/ha	0 a	0 a	0 a	0 a	0 a	703 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	2 a	0 a	0 a	714 a
10	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	0 a	0 a	0 a	0 a	0 a	495 a
11	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	0 a	1 a	0 a	0 a	0 a	721 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	0 a	2 a	0 a	1 a	922 a
Tukey's HSD (P=.05)			0	1.4	3.2	0	1.3	381.2
Standard Deviation			0	1	2.2	0	0.9	264
CV			0	467.1	275.78	0	406.85	37.49
Treatment Prob(F)			1	0.4671	0.4695	1	0.5849	0.4338

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 8: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling meadow brome grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Meadow Brome grass Visual Injury Percent 25-Jun-04	Meadow Brome grass Visual Injury Percent 9-Jul-04	Meadow Brome grass Visual Injury Percent 27-Jul-04	Meadow Brome grass Visual Injury Percent 14-Jun-05	Meadow Brome grass Visual Injury Percent 11-Jul-05	Meadow Brome grass Seed Yield kg/ha 25-Jul-05
1	WEED FREE CHECK		0 a	0 a	0 a	0 a	0 a	649 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	694 a
3	PUMA SUPER	184 g ai/ha	2 a	1 a	2 a	0 a	0 a	792 a
4	PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	2 a	0 a	0 a	0 a	0 a	701 a
5	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	1 a	1 a	3 a	0 a	0 a	763 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	4 a	1 a	3 a	0 a	1 a	818 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	0 a	1 a	3 a	0 a	0 a	748 a
8	BANVEL II	140 g ai/ha	0 a	0 a	0 a	0 a	0 a	833 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 a	0 a	0 a	920 a
10	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	0 a	0 a	0 a	0 a	0 a	907 a
11	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	1 a	0 a	0 a	0 a	0 a	820 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	1076 a
Tukey's HSD (P=.05)			3.4	2	2.9	0	1	271.6
Standard Deviation			2.4	1.4	2	0	0.7	188.1
CV			278.08	360.32	254.14	0	692.82	23.22
Treatment Prob(F)			0.4214	0.7208	0.2337	1	0.4671	0.1613

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 9: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling meadow brome grass stand – Melfort 2004-05.

Treatment	Rate	Meadow Brome grass Injury Percent 14 DAT	Meadow Brome grass Seed yield kg/ha
UNTREATED CHECK		0a	498ab
PUMA SUPER	92 gai/ha	0a	398b
PUMA SUPER	184 g ai/ha	0a	539a
PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0a	437ab
PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0a	527a
ATTAIN FLUROXYPYR 2,4-D LV ESTER	105 g ai/ha 560 g ai/ha	0a	464ab
ATTAIN FLUROXYPYR 2,4-D LV ESTER	210 g ai/ha 1120 g ai/ha	0a	496ab
BANVEL II	140 g ai/ha	0a	500ab
ACHIEVE 80 DG TURBOCHARGE	198 g ai/ha 0.5% v/v	0a	500ab
SPECTRUM FLORASULAM CURTAIL-M	5 g ai/ha 490 g ai/ha	0a	482ab
SPECTRUM FLORASULAM CURTAIL-M	10 g ai/ha 980 g ai/ha	0a	474ab
PUMA 92 SUPER	92 g ai/ha	0a	533a
MEAN		0	487.5
CV		.	14.7
LSD alpha= .05		0	103
Pr>F		.	ns 0.2799

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

7.0 TOLERANCE OF SMOOTH BROME TO PUMA SUPER

7.0.a Introduction

Smooth brome grass is a widely adapted grass species that has been used primarily for hay and pasture production. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in smooth brome grass. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of smooth brome grass. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

7.0.b Materials and Methods

Scott Seedling Trial 1

This trial was fall dormant seeded directly into wheat stubble on October 28, 2003 and emerged on April 28, 2004. The cultivar was Magna which was seeded at a rate of 8 kg/ha. Plots were harvested on July 25, 2005.

Herbicide treatments were applied on June 16, 2004. In the week preceding application 29.8 mm of rain fell with 2.2 mm falling within 10 days after application. The first significant rainfall after application occurred on July 1 when 11.8 mm of precipitation was recorded.

Scott Seedling Trial 2

Magna smooth brome grass was seeded at a rate of 8 kg/ha directly into wheat stubble on June 9, 2004. Plots were harvested on July 25, 2005.

Herbicide treatments were applied on July 13, 2004. In the week preceding application 14 mm of rain fell with 11.8 mm falling within 10 days after application. The first significant rainfall after application occurred on July 20 when 6.4 mm of precipitation was recorded.

In both studies at Scott, maintenance weed control consisted of a combination of hand weeding and mowing in 2004. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows. In 2005 broadleaf weed seedlings were controlled with a combination of 2, 4-D Amine applied early in the spring followed by hand weeding.

The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather. The year 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees Celsius below normal respectively. Precipitation over the course of the growing season May-August averaged 53% more than the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in minimal damage in the form of broken stems. Damage was consistent across the trial with no other impact than a slight reduction in seed yield.

7.0.c Results and Discussion

Scott Seedling Trial 1

Results are presented in Table 10. In 2004 visual observations indicated little evidence of Smooth Brome grass injury to Puma Super even at the 2 X rate. Crop injury to Puma Super took the form of stunting. Injury symptoms from Puma Super remained low in 2005 (<2%) with no evidence of seed yield loss relative to the untreated check or industry standard. Seed yield across the trial averaged 542 kg/ha.

Table10: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling smooth brome grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Smooth Brome grass Visual Injury Percent 25-Jun-04	Smooth Brome grass Visual Injury Percent 9-Jul-04	Smooth Brome grass Visual Injury Percent 27-Jul-04	Smooth Brome grass Visual Injury Percent 14-Jun-05	Smooth Brome grass Visual Injury Percent 11-Jul-05	Smooth Brome grass Seed Yield kg/ha 25-Jul-05
1	WEED FREE CHECK		0 a	0 a	1 a	0 a	0 a	788 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	1 a	633 a
3	PUMA SUPER	184 g ai/ha	0 a	1 a	0 a	0 a	1 a	605 a
4	PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0 a	0 a	3 a	0 a	1 a	780 a
5	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0 a	1 a	1 a	0 a	0 a	780 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	105 g ai/ha 560 g ai/ha	0 a	1 a	4 a	0 a	1 a	719 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	0 a	3 a	1 a	0 a	1 a	600 a
8	BANVEL II	140 g ai/ha	0 a	3 a	0 a	0 a	1 a	731 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 a	0 a	2 a	693 a
10	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	0 a	1 a	2 a	0 a	3 a	707 a
11	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	0 a	3 a	0 a	0 a	1 a	755 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	1 a	0 a	0 a	0 a	748 a
Tukey's HSD (P=.05)			0	3.3	3.9	0	2.1	163.3
Standard Deviation			0	2.3	2.7	0	1.4	113.1
CV			0	201.27	267.71	0	168.9	15.89
Treatment Prob(F)			1	0.6944	0.5832	1	0.4729	0.2189

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Scott Seedling Trial 2

Results are presented in Table 11. In 2004 visual observations indicated no evidence of Smooth Brome grass injury to Puma Super even at the 2 X rate. In 2005 no injury symptoms from Puma Super at the 2X rate were observed and no reductions in seed yield relative to the untreated check or industry standard detected (P=0.05). Seed yield averaged 672 kg/ha across the trial.

Table11: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling smooth brome grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Smooth Brome grass Visual Injury Percent 23-Jul-04	Smooth Brome grass Visual Injury Percent 6-Aug-04	Smooth Brome grass Visual Injury Percent 20-Aug-04	Smooth Brome grass Visual Injury Percent 14-Jun-05	Smooth Brome grass Visual Injury Percent 11-Jul-05	Smooth Brome grass Seed Yield kg/ha 25-Jul-05
1	WEED FREE CHECK		0 a	2 a	0 b	0 a	0 a	850 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 b	0 a	0 a	902 a
3	PUMA SUPER	184 g ai/ha	0 a	0 a	0 b	0 a	0 a	815 a
4	PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	1 a	1 a	1 b	0 a	1 a	868 a
5	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	1 a	0 a	0 b	0 a	1 a	847 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	105 g ai/ha 560 g ai/ha	2 a	1 a	1 b	0 a	0 a	941 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	5 a	4 a	10 a	0 a	1 a	951 a
8	BANVEL II	140 g ai/ha	1 a	1 a	0 b	0 a	0 a	916 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 b	0 a	0 a	713 a
10	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	0 a	0 a	0 b	0 a	0 a	897 a
11	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	1 a	0 a	0 b	0 a	0 a	920 a
12	PUMA 92 SUPER	92 g ai/ha	1 a	0 a	0 b	0 a	0 a	964 a
Tukey's HSD (P=.05)			3	2.5	3.6	0	1.1	142.4
Standard Deviation			2.1	1.7	1.5	0	0.7	98.6
CV			197.64	228.99	151.34	0	395.94	11.18
Treatment Prob(F)			0.1687	0.0849	0.0001	1	0.6077	0.0611

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

7.1 CONCLUSIONS

The results from the two studies conducted at Scott indicate that smooth brome grass was tolerant to seedling applied Puma Super under the growing conditions that existed at Scott in 2004 and 2005. Puma 92 Super which was included to generate bridging data with Puma Super showed similar levels of injury to Puma Super at the same 1X rate.

8.0 TOLERANCE OF SEEDLING TALL FESCUE TO PUMA SUPER

8.0.a Introduction

Tall Fescue is an introduced grass species that has been used for both grazing and hay production purposes. It is well adapted to acidic soils but also produces well in neutral soils. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in tall fescue. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of tall fescue. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

8.0.b Materials and Methods

Scott Seedling Trial 1

A burn-off with glyphosate was conducted on May 26th in preparation to seed. The test area was tilled with spring tooth harrows to 6 cm depth followed by diamond harrows, and packed on May 27th. This trial was seeded on May 28, 2004 to replace a study initiated in 2003 that failed due to poor crop establishment. The cultivar Guardian was seeded at a rate of 5 kg/ha. The crop emerged on June 13, 2004. Seed was harvested on July 26th.

Herbicide treatments were applied on June 28, 2004. In the week preceding application 0.3 mm of rain fell with 45.8 mm falling within 10 days after application in addition to 10 mm of irrigated water on June 30th. The first significant precipitation after application occurred on June 30 when 10 mm of irrigated water was applied.

Scott Seedling Trial 2

A burn-off with glyphosate was conducted on May 26th in preparation to seed. The test area was tilled with spring tooth harrows to 6 cm depth followed by diamond harrows, and packed on May 27th. Guardian tall fescue was seeded at a rate of 5 kg/ha on June 9, 2004. The crop emerged on June 24, 2004. Seed was harvested on July 26th.

In both Scott studies, maintenance weed control consisted of a combination of maintenance herbicides, hand weeding and mowing. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows in 2004. Registered herbicides were used in 2004 and 2005 to control broadleaf weeds.

At Scott, the year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather. The year 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees Celsius below normal respectively. Precipitation over the course of the growing season May- August averaged 53% more than the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in minimal crop damage in the form of broken stems. Observed damage was consistent across the trial.

Melfort Seedling Trial

A test area at the Melfort Research Farm was seeded to Courtenay tall fescue June 24, 2004 @ 9 kg/ha. Fertility levels were adequate to establish a grass seed crop.

Fall precipitation in 2004 was about 115% of the long term average and provided ideal moisture conditions for going into winter. Precipitation from January 1 to August 30, 2005 was nearly 170% of normal. Grass establishment was good with considerable amounts of biomass production.

Herbicide treatment application was done on August 1, 2004 in a randomized complete block design with the tall fescue plants at anywhere from the 2 to 4 leaf stage. Environmental conditions at and near the time of application are presented in Table 16 (APPENDIX). Visual ratings on % injury were done at 14 days after treatment (DAT). Injury ratings at 28 DAT and 42 DAT were not done due to an encroachment and unplanned grazing of the test area by cattle. However, it is unlikely that the grazing had any effect on the final seed yield. The test area was fertilized April 26, 2005, with 89 kg/ha N in the form of ammonium nitrate.

The test was swathed with a self propelled plot swather July 27, 2005. The swaths were allowed to dry enough in the field to be combined. Combining was done with a Wintersteiger plot combine on August 10, 2005. The seed harvested from each plot was then dried in a forced air drier and subsequently cleaned with a Clipper table top seed cleaner to determine clean seed yields.

8.0.c Results and Discussion

Scott Seedling Trial 1

Results are presented in Table 12. In 2004 visual observations indicated acceptable levels of injury (stunting) for Puma Super at the 1X rate with slightly higher injury at the 2 X rate leading to a just acceptable level of injury 25 days after application. Puma 92 Super which was included to create bridging data between the new and old formulation showed similarly low levels of injury to Puma Super at the 1X rate. Average seed yields across the study of 592 kg/ha were at the low end of the range (560-1350 kg/ha) generally anticipated for Tall Fescue.

Scott Seedling Trial 2

Results are presented in Table 13. In 2004 visual observations indicated acceptable levels of injury (stunting) for Puma Super at the 1X rate with slightly higher injury at the 2 X rate leading to a just acceptable level of injury 24 days after application. Puma 92 Super which was included to create bridging data between the new and old formulation showed similarly low levels of injury to Puma Super at the 1X rate. Average seed yields across the study of 552 kg/ha were at the low end of the range (560-1350 kg/ha) generally anticipated for Tall Fescue.

Table12: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling tall fescue grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Tall Fescue Visual Injury Percent 6-Jul-04	Tall Fescue Visual Injury Percent 23-Jul-04	Tall Fescue Visual Injury Percent 6-Aug-04	Tall Fescue Visual Injury Percent 14-Jun-05	Tall Fescue Visual Injury Percent 11-Jul-05	Tall Fescue Seed Yield kg/ha 26-Jul-05
1	WEED FREE CHECK		0 c	0 d	0 c	0 a	0 a	613 a
2	PUMA SUPER	92 g ai/ha	4 b	5 bc	4 abc	0 a	0 a	619 a
3	PUMA SUPER	184 g ai/ha	9 a	10 a	7 a	0 a	0 a	493 a
4	PUMA 92 SUPER	92 g ai/ha	6 b	7 ab	5 ab	0 a	0 a	566 a
5	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	0 c	1 d	0 c	0 a	0 a	682 a
6	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	0 c	2 cd	1 bc	0 a	0 a	548 a
7	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0 c	0 d	0 c	0 a	0 a	645 a
8	BANVEL II	140 g ai/ha	0 c	0 d	0 c	0 a	0 a	576 a
Tukey's HSD (P=.05)			2.4	4.4	4.3	0	0	152.6
Standard Deviation			1	1.8	1.8	0	0	103.7
CV			44.77	59.29	91.17	0	0	17.5
Treatment Prob(F)			0.0001	0.0001	0.0001	1	1	0.2907

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table13: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling tall fescue grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Tall Fescue Visual Injury Percent 6-Jul-04	Tall Fescue Visual Injury Percent 23-Jul-04	Tall Fescue Visual Injury Percent 6-Aug-04	Tall Fescue Visual Injury Percent 14-Jun-05	Tall Fescue Visual Injury Percent 11-Jul-05	Tall Fescue Seed Yield kg/ha 26-Jul-05
1	WEED FREE CHECK		0 d	1 b	1 b	0 a	0 a	686.3 a
2	PUMA SUPER	92 g ai/ha	5 bc	3 b	2 b	0 a	0 a	702.7 a
3	PUMA SUPER	184 g ai/ha	8 a	10 a	8 a	0 a	0 a	703.1 a
4	PUMA 92 SUPER	92 g ai/ha	6 ab	4 ab	3 b	0 a	0 a	688.5 a
5	SPECTRUM FLORASULAM CURTAIL M	5 g ai/ha 490 g ai/ha	1 cd	1 b	0 b	0 a	0 a	759.1 a
6	SPECTRUM FLORASULAM CURTAIL M	10 g ai/ha 980 g ai/ha	0 d	0 b	0 b	0 a	0 a	736.3 a
7	PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	1 d	0 b	0 b	0 a	0 a	808.2 a
8	BANVEL II	140 g ai/ha	0 d	0 b	0 b	0 a	0 a	715.2 a
Tukey's HSD (P=.05)			3.6	6.1	3.7	0	0	119.16
Standard Deviation			1.5	2.6	1.6	0	0	81.02
CV			59.53	104.36	90.14	0	0	11.18
Treatment Prob(F)			0.0001	0.0001	0.0001	1	1	0.4253

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Melfort Seedling Trial

Results are presented in Table 14. There were no significant differences in the reduction of seed yield from treatment application. No injury was detected as seen in the visual injury assessments done at 14 DAT.

Table 14: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling tall fescue grass stand. Melfort, 2004-05.

Treatment	Rate	Tall Fescue Injury Percent 14 DAT	Tall Fescue Seed yield kg/ha
UNTREATED CHECK		0a	1279abc
PUMA SUPER	92 gai/ha	0a	1287ab
PUMA SUPER	184 g ai/ha	0a	1156c
PRESTIGE FLUROXYPYR CURTAIL M	142 g ai/ha 660 g ai/ha	0a	1275abc
PRESTIGE FLUROXYPYR CURTAIL M	284 g ai/ha 1320 g ai/ha	0a	1239abc
ATTAIN FLUROXYPYR 2,4-D LV ESTER	105 g ai/ha 560 g ai/ha	0a	1301ab
ATTAIN FLUROXYPYR 2,4-D LV ESTER	210 g ai/ha 1120 g ai/ha	0a	1283abc
BANVEL II	140 g ai/ha	0a	1201bc
ACHIEVE 80 DG TURBOCHARGE	198 g ai/ha 0.5% v/v	0a	1190bc
SPECTRUM FLORASULAM CURTAIL-M	5 g ai/ha 490 g ai/ha	0a	1351a
SPECTRUM FLORASULAM CURTAIL-M	10 g ai/ha 980 g ai/ha	0a	1235abc
PUMA 92 SUPER	92 g ai/ha	0a	1222abc
MEAN		0	1252
CV		.	7.2
LSD alpha= .05		0	129
Pr>F		.	ns .01851

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

8.2 CONCLUSIONS

This evidence suggests that under the conditions experienced at Scott and Melfort, SK in 2004 and 2005, tall fescue grass seedlings were generally tolerant to applications of Puma Super. At Scott in 2005, observations at heading in both trials indicated that tall fescue plants treated with Puma Super exhibited more and larger seed heads than other treatments in the trial. This resulted in slight lodging but did not translate into higher seed yields.

9.0 EXTENSION ACTIVITIES

The project results were disseminated through extension activities:

Annual Western Applied Research Corporation (WARC) newsletter (2)

Annual Scott Field Days (2)

Poster presented at Canadian Weed Science Society

Annual WARC Research UpDATes, North Battleford (2)

10.0 OVERALL CONCLUSIONS

Most of the forage grass species tested in this study exhibited satisfactory tolerance to Puma Super. The only exception was the established crested wheatgrass study. Data mining will now be conducted to find supporting data. Once this has occurred, Pesticide Minor Use Coordinators in the Prairies will summarize the data for submission to the Pesticide Management Regulatory Agency.

11.0 REFERENCES:

Darwent, A.L., D.E. Cole, H.A. Loeppky and R. Esau. 1998. Guidelines for the conduct of chemical weed control trials in forage grasses grown for seed. Alberta Agriculture, Food and Rural Development. 26 pp.

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12.0 APPENDIX

ENVIRONMENT DATA FOR SCOTT AND MELFORT

Table 15. Monthly summary of environmental data for Scott, SK. (2003-05) and Melfort, SK. (2004-05).

<i>Precipitation (mm)</i>							
	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>Sept</u>	<u>Total</u>
<i>Scott</i>							
2003	24	22	34	66	44	43 ^a	233
2004	3	35	53	69	44	15	219
2005	27	41	100	77	88	75	408
Scott Long-Term Average	23	36	60	59	45	32	255
<i>Melfort</i>							
2004	21	34	66	56	54	52	283
2005	13	37	166	70	99	97	482
Melfort Long-Term Avg.	25	46	66	76	57	27	297
<i>Mean Monthly Air Temperature (° C)</i>							
	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>Sept</u>	<u>Mean</u>
<i>Scott</i>							
2003	4	11	15	18	20	10	13.0
2004	5	8	13	17	14	10	11.2
2005	5	9	13.5	18	13	10	11.4
Scott Long-Term Average	3	10	14	17	16	10	11.8
<i>Melfort</i>							
2004	3	7	13	17	14	11	10.8
2005	6	9	14	17	15	11	11.9
Melfort Long-Term Avg.	3	11	16	18	16	11	12.5

Table 16. Weather information describing conditions around the timing of treatment application of various herbicides on intermediate wheatgrass near Melfort in 2004.

Wind	Temperature	Precipitation				
Speed and direction	at time of application degrees C	week before (mm)	1 st week after (mm)	2 nd week after (mm)	days to 1 st significant rainfall (mm)	amount of 1 st significant rainfall (mm)
West @12 km/hr	20	6.8	1.3	7.1	8	6.3

Table 17: Equivalent rates of herbicides used in trials.

Treatment	Rate g ai/ha	Rate liter/acre
PUMA 120 SUPER 1X*	92	0.31
PUMA 120 SUPER 2 X**	184	0.62
PRESTIGE 1X FLUROXYPYR	142	0.32
CURTAIL M	660	0.8
PRESTIGE 2X FLUROXYPYR	284	0.64
CURTAIL M	1320	1.6
ATTAIN 1X FLUROXYPYR	105	0.24
2,4-D LV ESTER	560	0.40
ATTAIN 2X FLUROXYPYR	210	0.48
2,4-D LV ESTER	1120	0.80
BANVEL II 1X	140	0.12
SPECTRUM 1X FLORASULAM	5	0.04
CURTAIL-M	490	0.60
SPECTRUM 2X FLORASULAM	10	0.08
CURTAIL-M	980	1.20
PUMA 92 SUPER	92	0.40

*1X = label rate

**2X = two times the label rate to simulate sprayer overlaps.

Forage Seed Production Factsheet for Intermediate wheatgrass, Crested wheatgrass and Meadow brome grass.

This factsheet is intended as a condensed guide to pedigreed forage grass seed production in Saskatchewan for Intermediate Wheatgrass, Crested Wheatgrass and Meadow Brome grass. Forage seed producers must apply to become members of the Canadian Seed Growers Association (CSGA) before they can produce and sell pedigreed seed. Pedigreed seed producers must read and understand the CSGA publication "Pedigreed Forage Seed Production" and "Regulations and Procedures for Pedigreed Seed Crop Production (Circular 6-94)". Pedigreed seed producers must meet the requirements of the CSGA regulations for forage seed production. Forage seed producers must also meet the requirements of the "Canada Seeds Act and Regulations" that permits the seed to be advertised and sold by variety name. These documents and regulations may be obtained from the Canadian Seed Growers Association (CSGA) and the Canadian Food and Inspection Agency (CFIA). Please contact these agencies directly through their individual web sites or contact Saskatchewan Agriculture and Food. Study the Acts and Regulations that govern Plant Breeders Rights, the Plant Protection Act and the Seed Act. **Make sure you are familiar with the rules and regulations governed by the CSGA and the CFIA for pedigreed seed production in Canada.**

Intermediate Wheatgrass (*Thinopyrum intermedium*)

Intermediate wheatgrass (IWG) is considered to be a short-lived, creeping-rooted perennial species best adapted to the black, grey and moist dark brown soil climatic zones. The highest seed production will be obtained in areas that receive 350-500 mm annual precipitation. Average seed yield of IWG is 150 kg/ac, but yields have been recorded as high as 400 kg/ac.

Crested Wheatgrass (CWG)

The most common type of CWG is *Agropyron cristatum*, with both diploid ('Fairway' type) and tetraploid varieties available. There is also a tetraploid species, *Agropyron desertorum*, ('Standard' type), but it is much less commonly grown in western Canada. The tetraploid varieties are taller, with larger heads and seeds than the diploid; thus they require a higher seeding rate. Floret seed set is about 50% for *A. desertorum* and up to 70% in *A. cristatum*. Seed yields are more consistent in areas that receive 350 – 500 mm annual precipitation. In Saskatchewan, the average seed yield of CWG is 150 kg/ac, but yields of 450 kg/ac have been recorded.

Meadow Brome grass (*Bromus riparius*)

Meadow Brome grass (MBr) is best adapted for seed production in the dark brown, black and grey wooded soil climatic zones. MBr is a long-lived, perennial bunch grass that produces a mass of basal leaves. This basal leaf development contributes to its ability to regrow leaf material quickly after being harvested and to its reputation as a grazing grass species. However, this mass of basal leaves often leads to problems at harvest time. MBr leaves have short hairs as long as the margins of the leaves. MBr is winter hardy and moderately tolerant to saline conditions. MBr is drought tolerant but has a low tolerance for spring flooding. Average seed yields in Saskatchewan range between 125 and 150 kg/ha, but yields as high as 350 kg/ha have been recorded. MBr generally produces economical yields for 2 to 3 years; while IWG and CWG will generally produce economical seed yields for four years or more. However, management will ultimately determine the longevity of most forage seed stands.

Pedigree Grass Seed Field Selection:

In general, grass species are cross-pollinated by wind and occasionally by insects. Therefore, pedigreed seed production must ensure adequate isolation requirements. The isolation requirements for each species are listed in the Canadian Seed Growers Associations' publication of the regulations and procedures.

Fields selected for pedigree seed production must be free of noxious grassy and broadleaf weeds, especially weeds of similar seed size such as quackgrass, Canada thistle, perennial sow thistle, wild oat, stickseed (blue bur) and Persian dandel. The seeds of these weedy species are extremely difficult to clean out of grass seed lots, and their presence may exclude that seed lot from the Canadian or foreign market.

A seemingly unexpected problem weed in grass crops is wild mustard. At harvest time, the unthreshed wild mustard seeds may lodge in the beak of the wild mustard seedpod and this broken remnant of the pod is nearly impossible to remove. Weeds such as quackgrass, Canada thistle, cleavers, perennial sow thistle and wild mustard are all **Primary Noxious Weeds**. No primary noxious weeds are allowed in any pedigreed seed grade under the Canada Seeds Act. Please refer to the Weed Order of the Canada Seeds Act for a complete list. Secondary noxious weeds like wild oat, Persian dandel, scentless chamomile, stickseed and stinkweed can be tolerated in minimal levels. Other weeds, such as shepherd's purse, and other crops, such as crested wheatgrass in meadow brome, are tolerated in higher levels, but any diligent grower would aim to produce the highest quality possible, and will be rewarded financially for it.

Field Records:

Accurate records of individual fields are extremely important. Consult your field records for possible herbicide residue, past cropping practices or crop species that may complicate or reduce the likelihood of success. Some examples of herbicides of known detrimental residue effects on perennial grass species are trifluralin products, Atrazine, Princep /simazine, Pursuit, Odyssey and Sencor. For complete up to date information on herbicide action and long-term effects, refer to the yearly provincial **Crop Protection Guide**. Read the information provided in this publication carefully and know each herbicide product's negative and positive attributes before using it in your cropping rotation. **If, after consulting the publication you are still not sure if a particular pesticide product can be safely applied to your crop, have the information verified by the appropriate pesticide control company or forage agronomist.** Grasses should not be sown for 24 months following a spring application, or 30 months following a fall application, of trifluralin herbicides. Dry conditions may increase the soil carry over and therefore increase the time required before it is safe to seed grasses.

Weed Control:

Weed control should begin three to four years prior to field selection. An elite pedigreed seed grower is continually vigilant and does not allow weedy species to go to seed to replenish the weed seed bank. Growers should be aware of weedy species' growth curves and periods of the year when problematic weedy species are easiest to control. Consider using integrated cropping methodology such as delayed seeding of wheat and barley, or green manure, green feed or silage crops. These crops will remove weedy species from the fields before the weeds are allowed to produce viable seeds. Ensiling has the advantage of removing weedy plants while still moist and thereby reducing the likelihood of viable seeds being dropped or shattered during the harvesting operation. In addition, ensiling reduces seed viability during the fermenting process and renders most weed seeds non-viable. Ensiling reduces the likelihood of contaminating a field if the manure from cattle fed the forage is spread back on the land. The rumen of cattle could be purged of viable weedy seeds using ensiled forages before they are allowed to graze the residue of grass seed fields after harvest. Avoid applying non-composted manure to fields targeted for pedigree seed production as this may provide sources for weed seed contamination. Crowns and rhizomes from certain perennial grass crops and weedy species will re-establish in the seedling stand. To avoid cross contamination of individual seed fields, equipment must be thoroughly cleaned prior to being moved from one field to the next.

Land must be free of perennial weedy species. Preharvest applications of glyphosate in the preceding crops are effective to control quackgrass, Canada thistle and sow thistle if the

treatment is applied over several years prior to seeding the seed crop. An application of glyphosate prior to seeding or within a few days after seeding, but prior to seedling emergence will also reduce the adverse competitive effect of weedy species.

For a complete up to date reference on herbicides registered for grassy and broad leaf weed control in forage grass seed crops, refer to the annual Provincial Crop Protection Guide. This publication may be obtained from Saskatchewan Agriculture and Food.

Grass Establishment:

Grass seed crops must not be seeded more than 1 to 2.5 cm ($\frac{1}{2}$ to 1 inch) deep into a firmly packed seedbed. The goal is to maximize germination and rapid emergence of seedlings. Research has shown that as seeding depth increases, time to emergence increases and seedling survival and establishment decreases. Therefore, seeding equipment must be well tuned ahead of time and depth control must be maintained accurately throughout the seeding operation. Standing stubble provides a firm seedbed to properly place seeds, provides a microclimate for seed germination and seedling development, and provides protection from wind and water erosion. Using zero-till technology and/or using a stale seedbed are excellent choices and provide additional depth control for most seeding equipment. The sole of your boot should not sink more than 1 cm ($\frac{1}{4}$ inch) into the soil surface prior to seeding. If using a disc type opener, depth control bands on discs will help maintain shallow seeding depth and will result in a uniform stand.

If seeding into stubble, the previous crop residue must be managed properly before seeding. The straw residue should be removed by baling and the chaff spread evenly by harrows or removed completely using a chaff collector at harvest time. Straw and chaff removal also reduces the weed seed bank in the field.

Research has shown that most grass crops must be sown prior to July 25th if a seed crop is to be expected the following year. In addition, the risks of establishment failure increase substantially as you delay seeding from May 1 to the end of July. However, the soil temperature must have reached at least 4°C before the time of seeding or you may have problems with seedling diseases such as root rot and damping off.

Calibrating seeding equipment on the basis of seeds per linear foot of row takes the guesswork out of equipment calibrations. Run the seeding equipment over a sheet of plywood or concrete pad to determine the number of seeds being sown per linear foot of row. The seeder should be calibrated to seed 12-20 seeds per linear foot of seed row. Seeding rates generally decrease as a pedigreed seed producer becomes more experienced at establishing forage grass stands.

Clipping or mowing can be an effective alternative to herbicides to reduce the impact of weedy species within a stand. However, the seed producer must mow low enough to prevent weedy species from producing viable seed. Weedy species can be very adaptive and may begin to grow less upright and more prostrate if only the tops are removed, allowing them to produce viable seed.

Pre-seeding Fertility:

Soil sampling is a vital element of all well managed agriculture production systems. Soil sampling will provide a benchmark nutrient level from which to make sound management decisions. In general, 20-40 lb/ac of nitrogen should be applied before seeding on stubble, or 40-60 lb/ac under irrigation. However, excess nitrogen may result in added competition from weeds, which may reduce the competitiveness of very weak forage seedlings. The application of at least 30 lb/ac in the autumn of the year of establishment will promote maximum seed production in the following year. The quantity of fertilizer that can safely be placed in the seed row depends on soil organic matter and clay content, moisture content, interval between

seeding and first precipitation event, row spacing and seed row spread. As the organic matter and clay content increase, risk of fertilizer injury decreases. As the row spacing increases for a given fertilizer rate, the concentration of fertilizer within the seed row increases. Rainfall replenishes the soil moisture and removes fertilizer salts from the immediate vicinity of the seed. The general guideline is to not place any nitrogen (N), potassium (K), or sulphur (S) in the seed row.

Phosphate and K are relatively immobile in the soil and deficiencies are best corrected prior to establishment of the seed crop. Phosphorus is required for strong root growth and plant development. Fields testing less than 6.8 kg P/ac (15 lbs/ac) require 23 to 34 kg P_2O_5 /ac (50-75 lb/ac). Fields testing less than 90 kg K/ac (200 lb/ac) require at least 45 kg K/ac (100 lb/ac) before sowing the grass.

Sulphur (S) is relatively mobile and deficiencies may be easily corrected provided the deficiency symptoms are recognized soon enough. Fields where canola has been sown previously may be deficient in sulphur.

Carriers:

Carriers are essential for bulky, chaffy grasses such as meadow bromegrass. Carriers help to improve seed flow and eliminate bridging in the seed tank. Polymer seed coatings improve seed flow and minimize exposing the operator to seed treatments that may have been applied to the seed. Up to 6.8 kg P_2O_5 /ac (15 lb/ac), or 13 kg/ac (29 lbs/ac) 11-52-0 fertilizer may be added with the seed to improve flow. However, the phosphate carrier is generally mixed with the seed in a ratio of 1.0 kg seed/1.0 kg P fertilizer, but more fertilizer may be required for chaffier seed lots. Seed mixed with phosphate fertilizer may be stored up to 3 weeks under cool, dry conditions before seed viability will begin to decrease. Non-viable grain or vermiculite clay may also be used to improve the seed flow and prevent bridging. An alternative is to only partially fill the seed tank with seed. The seeder can also be fitted with seed tank agitators that will improve seed flow to the outflow tubes.

Row-spacing:

Most grass seed crops produce the most seed if sown in rows spaced on 30 to 90 cm (12 to 36 inch) centres. Narrow rows will result in quicker establishment, provide more competition to weedy species and result in higher seed yields in the year following establishment. However, yield will decline quicker as the grass plants begin to compete with each other for nutrients, moisture and sunlight. In general, wider row spacing will result in lower yield in the first year, but higher yields will be maintained in subsequent years. In addition, wider rows reduce seed costs, facilitate row-cropping tillage, and encourage plant tillering and seed head development. However, the limited stubble as a result of wider row spacing may not provide adequate support for the crop swath to facilitate air movement under and through the swath to speed drying. Some producers alternate the row spacing between groups of 3-4 rows on 30 cm (12 inch) row spacing, leaving a 60 to 90 cm (30 to 36 inch) gap and then going back to another 3-4 rows on 30 cm (12 inch) row spacing. This type of seeding pattern will allow the swath to be laid directly and supported by the stubble from the group of 3 to 4 narrower rows at harvest.

Companion Crops:

In general, seed yields of grass stands will be higher if a companion crop is not used in the establishment year. Seedlings will grow larger, tiller more and compete more effectively with weeds during establishment if grown without a companion crop. However, if a companion crop is deemed necessary, ensure that the companion crop offers the least amount of competition possible by reducing seeding rate, reducing nitrogen fertility rate and removing it early in the growing season to allow the grass seedlings to become established. Under extreme drought conditions, companion crops will seriously suppress forage seedlings and this may result in complete loss of the stand.

Disease and Insect Monitoring:

The most common disease or insect problem in intermediate wheatgrass, crested wheatgrass and meadow brome grass is silvertop. Silvertop reduces seed yield by prematurely halting seed head development. The seed head emerges from the stem, but turns white and dries up, and is usually caused by insects that puncture the stem. If silvertop infected greater than 10% of the stand in the previous year, it is recommended that the field be sprayed with dimethoate prior to the early boot stage of the grass.

Using resistant cultivars and burning of crop residue after seed harvest will help control leaf spot. Care must be taken to avoid damage to the crowns and bud during the burning operation that could result in reduced seed yield in the following year.

Ergot is a seed borne disease and can be reduced by sanitation and by using ergot-free seed. The sticky honeydew on the surface of ergot-infected florets is spread to healthy florets by insects and rain during flowering. Mowing field edges during flowering will reduce the infection from these adjacent areas. Burning straw residue in the fall after seed harvesting will also reduce the survival of ergot bodies.

Stem or head smut is not common but can occur in meadow brome grass. The seed may be treated with a fungicide seed treatment if a problem is anticipated. It cannot be controlled by burning, straw residue removal or seed treatments as the pathogen is harboured in underground buds and in the soil. Head smut is primarily seed borne. In meadow brome grass, affected plants have shortened stems, which bear an erect, compact panicle.

For more in-depth information regarding forage crop diseases refer to the publication "Diseases of Field Crops in Canada". Editors: K. L. Bailey, B. D. Gossen, R. K. Gugel and R. A. A. Morrall. Third Edition (2003).

Preharvest Inspection:

Pedigreed seed producers must arrange to have their seed fields inspected and will pay inspection and membership fees through the CSGA. Remember to have all seed tags and documentation ready for the inspector at the time of inspection. Two inspections are required annually (a field inspection and seed analysis). The field must be inspected after heading, but before the crop can be swathed, harvested or straight cut or the seed production for that year will not be granted pedigree status.

Harvest:

Grasses need about 30 days after flowering for seeds to develop. Hot, dry weather shortens the ripening period, while high fertility and cool, moist conditions will delay maturity. Ripening begins at the top of the stem and proceeds down. Intermediate wheatgrass is ready to swath at the medium to hard dough stage of the seed, which corresponds to seed head moisture content between 50-55%. On the other hand, crested wheatgrass is ready to harvest in the hard dough stage, which corresponds to seed head moisture content between 35-40%. Meadow brome grass swathing can begin when the seed heads are between 50-55% moisture content. At this stage of development, thumbnail pressure is needed to imprint the seed. Seed heads are getting brittle, the upper part of the stem is turning brown, the top of stem will snap between the fingers and some seed will shatter when the seed head is firmly struck against the palm of the hand.

Forage grass seed crops generally shatter very easily and as such, straight combining these crops has tremendous risks associated with it and timing is critical for success. Despite the risks, some forage grass seed producers prefer to straight combine whenever possible. However, swathing is usually the least risky method of harvesting provided there is enough biomass to form an adequate swath. Straight combine harvesting may be less risky in years of

low seed yield, early maturity or reduced foliage. Swathing at an angle across seed rows will suspend the crop above the ground and allow air to pass through the swath and speed air-drying of the crop. Swathing in early morning, evening or at night when the relative humidity is higher will reduce shattering losses. Seed heads should be laid in the centre of the swath to help retain seed that has shattered during the swathing operation. Shatter can be reduced at swathing time by using minimum reel and draper speed that lays a good swath yet is gentle with the cut material. Most forage grass seed producers suggest keeping the swath cut at a maximum of twenty feet or less. A lighter swath will dry faster than a heavy dense swath. In general 10-12 inch stubble should be left to hold the swath.

There is a danger in swathing meadow brome grass, due to its ability to regrow, particularly in years with ample June and July moisture. Steps may have to be taken to lift the swath out of the regrowth so that it can dry properly.

Crested wheatgrass is ready for straight cutting at the first hint of seed shatter. Tetraploid types are less prone to seed shatter than are the diploid types. Once seed begins to shatter, the crop must be harvested as soon as possible to prevent complete loss of the seed crop. At this point, the risk of losing the crop from brisk winds or storms is high.

In general, as the swathing time draws near, the seed heads of grass species will begin to brown from the top and proceed down. At swathing time, the stem just below the seed head should begin to turn brown. Seed will shatter when firmly struck against the palm of the hand.

Pre-swathing Moisture Content:

To determine the moisture of the seed head (spike or panicle), collect about 100 grams of seed heads by clipping just below the seed heads. Weigh the sample as soon as possible after collecting it. Waiting too long after sampling to obtain the initial weight will increase the error in the final calculation. Dry the sample in a microwave or kitchen oven set at 82°C, checking often until the weight remains constant. If using a microwave, placing a glass of water in the microwave along with the seed heads will prevent the sample from burning which increases your error in the final calculation. **If the sample burns during the drying process, you must resample and start all over.** The sample should be weighed every few minutes until the weight of the dry sample remains constant. The dry moisture content of the samples is equal to ____ %Moisture = $(\text{wet weight} - \text{dry weight}) / \text{wet weight} * 100$.

Combine Settings:

The grass seed crop is usually ready to harvest 4-7 days after swathing. The combine must be thoroughly cleaned before beginning to harvest. Set the concave opening and cylinder speed so that the lemma and palea (husk) are retained on the seed. Retaining the husk will increase the long-term viability of the seed. In addition, concave setting and cylinder speed will have a significant influence on the amount of straw and debris in the return and on the sieves. This will ultimately influence how clean the seed is in the seed tank and how much viable seed is lost over the return. Very chaffy seed lots dramatically slow down producer handling and the cleaning process in the seed cleaning plant, which can increase conditioning costs. Dockage and seed cleaning costs may increase substantially if the producer tries to thresh out all the seed from heads and prevent all seed from going over the sieves. Therefore, the seed producer will have to strike a balance between the amount of peeled or broken seeds and the ability to properly thresh seed from heads.

The concave should be adjusted so that it minimizes straw breakage so as not to overload the sieves and return. For all grass species the airflow should lift the chaff about 10 cm above the front of the sieve so that the seed can be separated from the chaff. Assess the amount of seed going over the sieve. Generally setting the chaffer at 13-15 mm (1/2-5/8 inch) and the cleaning sieve at 3-6 mm (1/8-1/4 inch) is a good place to start. A judgement call has to be

made between too clean and too dirty and throwing viable seed over the sieve. However, a slow forward speed of 1.5–3 km/hr (1-2 mph) can significantly reduce seed loss during harvest.

Table #1 General Combine Settings For Harvesting MBr, IWG or CWG					
Species	Fan setting	Concave Opening	Cylinder Speed	*Sieve Opening	Comments
Meadow Bromegrass	400-500 rpm with shutters closed	1/16 inch	850 rpm	Top and bottom wider than for wheat	Maturess 1 week earlier and shatters easier than smooth bromegrass
Intermediate Wheatgrass	400-500 rpm with shutter open 2 inches	3/8 inch	800 rpm	½-5/8 inch on top and 1/8 – ¼ inch on bottom	Shatters easily and matures 3 wks later than smooth bromegrass
Crested Wheatgrass	400-500 rpm with shutter closed	3/8 inch	**800 rpm	½-5/8 inch on top and 1/8 – ¼ inch on bottom	Shatters easily, especially diploids

Note: * Sieve opening is a balance between overloading the return, allowing too much seed to walk over the sieve and having a clean or dirty sample. Aim for 10 to 15 percent dockage, with few peeled seeds, a very small amount of straw and few partial seed heads.

**There can be large amounts of “doubles” in some years, which can indicate poor pollination conditions. These doubles can generally be separated in the conditioning process, but increasing cylinder speed by 100 RPM may be more effective.

Seed Moisture Content at Harvest:

Generally the forage grass seed can be harvested at up to 20 % moisture content. If the crop is harvested in tough or damp condition, it must be dried soon after harvest to avoid heating, as this will result in lost of seed viability. Many producers use aeration bins, but small lots of seed can be dried by installing aeration tubes in the grain truck used to haul the seed from the field to storage bins.

Seed Storage and Moisture Content:

A cautious forage seed grower will do a quick initial cleaning to remove green leaves; insects and chaff on a fanning mill or sieve to reduce the likelihood of heating. The seed must be dried down to moisture content of 10-12% moisture content for short-term storage of one year or less. Drying the seed down to a moisture content of 8-10% will facilitate storage of the seed for one year or more. **A word of caution**, when using a grain drier to dry forage grass seed to these moisture levels, avoid overheating the seed, which will reduce the viability of the seed. The risk of injury from overheating the seed during drying is less at lower moisture contents than when the seed is very damp. In addition, high ambient temperatures in July and August may pose additional risks of heating.

Handling of Bulky Seed:

Intermediate wheatgrass and crested wheatgrass flow reasonably well if the dockage is less than 20 %, and in dry condition. But patience is very important with meadow brome grass, as it is not easy to move. It will not flow out of a hopper bin following aeration; therefore flat bottom bins with access are important. A pitchfork or stick may be necessary when loading, unloading or emptying a bin.

Post harvest Residue Management:

Windrow the straw behind the combine and bale and remove from the field soon after seed harvest. It is wise to use a chaff collector behind the combine to collect the chaff, seed and weed seeds that are thrown over the sieves during the harvest operation. Chaff collection will increase the life of the stand by reducing the number of new seedlings established next season and reduce the labour costs rouging out undesirable weedy species. The remaining stubble should be cut to a length of 10-15 cm (4-6 inches) after harvest and the residual removed. If the fall is very dry, a longer stubble length could be maintained until early spring, and then removed.

In meadow brome grass stands, the stubble should be mowed quite low to remove the basal leaf development that could smother the new tillers that are developing. This residue is generally of very good forage quality and is easily marketed to livestock producers.

Post-harvest Fertility:

In order to flower, grass tillers must be exposed to short days and low temperatures (cool short days of fall and long warm days of spring). Tillers must have grown enough to be induced to form seed heads by the correct daylight and temperature for each species.

A soil test should be conducted each fall to show benchmark levels of fertility as basis for fertilizer application rates. Nitrogen promotes tiller development. If moisture is available in early September, 9 to 12 kg/ac N (20 -25 lb/ac) should be applied each fall to promote tiller development and increase the likelihood of the development of seed forming tillers next season. In general, nitrogen applications of 32 to 36 kg N/ac (70-80 lb N/ac) in October will stimulate seed head development in the spring. Alternatively, apply 32-36 kg N/ac (70-80 lb N/ac) in the spring as soon as the land is dry enough to support the weight of the equipment.

Under irrigation, you should expect to apply 100 – 125 lb N/ac. If lodging occurs, reduce the application rate of nitrogen or split the application. The best source of nitrogen is ammonium nitrate (34-0-0), which is highly soluble in water and readily moves in the soil moisture to the plant roots.

Because grasses efficiently absorb water from the soil, ammonium nitrate is not subject to leaching or denitrification, volatilization or absorption to stubble residues. However, urea is cheaper and using a coulters applicator for accurate seed placement will dramatically increase its efficiency. Liquid UAN (28-0-0) is an excellent source of nitrogen, especially if applied under cloudy conditions, either dribbled on the surface or injected with a spoke or coulters applicator. The ammonium in urea (46-0-0) and ammonium sulphate (21-0-0-24) is less accessible to the plant and more vulnerable to loss by volatilization.

Forage Grass Seed Stand Removal:

Much of the soil benefits of having forages in rotation are lost if they are not "disposed" of properly. Provided that the seeding equipment used is capable, one of the best methods of killing the stand is with glyphosate, followed by direct seeding into the stand with a competitive, drought resistance crop that you can use herbicide to control volunteer crop. If tillage is used, the number of passes can be reduced with another application of glyphosate. Usually intermediate wheatgrass and crested wheatgrass can be controlled with two applications of glyphosate at 1.5 L/ac, done after harvest and bale removal, and again in the

spring. However, meadow brome grass is more difficult to kill than intermediate wheatgrass or crested wheatgrass. One option is to spray with 1.5 L/ac in late August, disc it twice in September or October, and spray 1 L/ac again in spring, then cultivate and harrow, followed by seeding. The soil will be dry and nitrogen deficient, but relatively weed free. More research is required to investigate the best possible means of removing forage seed stands quickly and efficiently to facilitate the inclusion of more forage crops in annual crop production systems. Producers should contact their provincial forage specialist to determine the best course of action to follow when removing a forage stand.

Information for this fact sheet was obtained from the following sources:

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